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ABSTRACT

This paper presents a methodology for estimating the full cost of parental time allocated to child-care activities at home. Building upon the human capital hypothesis, a model is developed in which the cost of an hour diverted from labor market activity is seen as consisting of three components: 1) direct wages foregone; 2) investments in on-the-job training foregone; and, 3) human capital losses associated with skill depreciation. The model is estimated for a sample of 535 mothers of elementary school children in an affluent district in New York State. For this sample, the full cost of an hour spent in child-care activities is estimated to be approximately twice the observed market wage. In terms of total resources entering the educational process (school plus home inputs), the analysis suggests that small changes in out-of-school time use represent substantial changes in the overall length of educational resources allocated to children. (Author)

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ESTIMATING THE FULL COST OF FAMILY-FINANCED TIME INPUTS TO EDUCATION*

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Estimating the Full Cost of Family-Financed Time Inputs to Education

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abstract

This paper presents a methodology for estimating the full cost of parental time allocated to child-care activities at home. Building upon the human capital hypothesis, a model is developed in which the cost of an hour diverted from labor market activity is seen as consisting of three components: 1) direct wages foregone; 2) investments in on-the-job training foregone; and, 3) human capital losses associated with skill depreciation. The model is estimated for a sample of 535 mothers of elementary school children in an affluent district in New York State. For this sample, the full cost of an hour spent in child-care activities is estimated to be approximately twice the observed market wage. In terms of total resources entering the educational process (school plus home inputs), the analysis suggests that small changes in out-of-school time use represent substantial changes in the overall level of educational resources allocated to children.

ESTIMATING THE FULL COST OF FAMILY-FINANCE TIME INPUTS TO EDUCATION

INTRODUCTION

The 1970s have been characterized as a decade of school finance reform in which equalization of "educational opportunity" was the paramount objective. Much of the legislative and judicial activity associated with this reform relied upon research on the allocation of public funds. In general, differences in per-pupil expenditure in public school districts within the same state were the central focus of inquiry. While some research did examined inter-state differences and differences in allocation between buildings or students within the same district, surprisingly little attention has been paid to the family's role in educational finance. Aside from parental behavior in the choice of residential location, the impact of family decision-making on the level of educational inputs has received little attention. As J. Allan Thomas notes, "many of the inequalities that persist despite efforts to eliminate them result from differences in students' home backgrounds, a commitment to equal opportunity implies in part an attempt to utilize schools as society's agents in reducing home-based inequalities."[1] In some ways the greatest limitation of the reform movement of the seventies was the exclusion of these home-based inequalities from explicit consideration as components of educational finance.

The 1980s have been characterized as a decade of retrenchment. Public disillusionment with government interventions, the sustained recession and concomitant budget deficits, as well as the "New Federalism," suggest a more limited role for the government in reforming educational finance. Two events in particular--the proposed granting of tuition tax credits for elementary and secondary education and the Coleman, Hoffman & Kilgore study of Private and Public Schools[2]--suggest possible movement toward increased reliance upon family finance of elementary and secondary

education. Ironically, it may be this very movement toward privatization that results in a more comprehensive view of the family's role in educational finance in general. If inter-family differences in ability or willingness to allocate resources to education become the principal determinants of expenditures on schooling, patterns in the allocation of out-of-school educational resources may also come under scrutiny. That is, once we recognize that resources allocated in the formal school sector are only a part of the total cost of education, we move closer to developing a more comprehensive model of the full cost of family-financed education. This paper examines the cost of parental time inputs to children at home, develops a methodology for estimating the opportunity cost of an hour of parental time, and considers the relative importance of these time inputs as a component of the full costs of education.

FAMILY CHARACTERISTICS AND ACHIEVEMENT

One of the most robust findings of educational input-output research is that family characteristics are powerful predictors of educational success in school. While family characteristics such as parental education and income are positively related to educational outcomes in virtually all studies, the mechanisms through which family advantage is transmitted are not well understood.[3] Children from advantaged households enter school with more cognitive skills than their peers and differences increase, on average, throughout the school experience. Apparently, substantial educational production occurs in the home both prior to and during the school years. Although research on this aspect of the household production process is limited, there is evidence that a key factor may be the way parents allocate time to the development of human capital in their children.[4]

While parental time spent with children may have a positive impact on the child's performance in school, this use of time may negatively affect parental earnings both in the current period and in the future. It is commonly observed that work experience and earnings are strongly correlated. To the extent that parents allocate time away from market activity to care for children, they may be incurring costs of three types. First, there are the immediate costs of wages foregone in the current period. Second, to the extent that training occurs on-the-job, such training is also foregone. Finally, if skills deteriorate when they are not used, "depreciation" may constitute a third component of the total costs of time spent with children.[5] In two-parent families, primary responsibility for child-care has traditionally fallen to women. It is well established that while the presence of children is associated with increased labor supply and wage rates for men, the opposite is true for women. Moreover, the negative impact of children on their mothers' wages persists over the lifecycle. Time spent caring for children at home carries, in addition to the direct cost of wages foregone in the current period, a lifetime cost of lowered earnings potential.

This paper develops a method for estimating the opportunity cost of time spent with children. An extended human capital model is derived and used to estimate the combined effects of work interruptions and reduced hours on the wages of women with elementary school children.

THE HUMAN CAPITAL EARNINGS FUNCTION

The human capital earnings function (HCEF) describes the relationship between earnings and prior investments in schooling and on-the-job training (OJT).[6] Two versions of the HCEF are derived below and the second is used to estimate the opportunity cost of time diverted from market activity by women.

We begin by defining potential earnings in year i (E_i) as the dollar income that an individual could receive if all standard working hours (SWH) were devoted solely to the production of money income. In any year, E_i may consist of three components: actual money income (Y_i), investment in human capital (C_i), and nonmarket activity in (during SWH) the form of consumption or household production (N_i). By definition, the three components sum to SWH.

THE BASIC MODEL

An implicit of assumption much of the empirical work in this area is that N_i equals zero in all prior periods. That is, individuals devote all SWH to either producing money income or investing in OJT. The model is frequently estimated with cross-sectional earnings data and data on schooling and potential experience. In general, this appears to be a reasonable assumption when considering the experience of middle class male workers. If k_i is defined as the proportion of potential earnings invested in human capital in year i ($ki=Ci/Ei$), then

$$(ki = Ci/Ei)$$

$$Y_i = E_i - C_i = E_i - k_iE_i = E_i(1-k_i). \qquad (1)$$

If r_i is defined as the rate of return to investments made in period i (C_i), potential earnings in the following year (i+1) increase

$$E_{i+1} = E_i + r_iC_i = E_i+r_ik_iE_i \qquad (2)$$

If k_i is assumed to define linearly over time, it can be shown that the logarithm of wages in a specific year t (W_t) can be approximated as a linear function of schooling (S), work experience (t) and experience squared (t^2),[7]

$$\ln W_t \approx (\ln E_{-s} - k_0 - \ln SWH) + r_s S + (r_p k_0 + [k_0/T])t - ([r_p k_0]/2T)t^2 \qquad (3)$$

in which:

E_{-s} = earnings potential at the start of school,

k_0 = proportionate investment in the first year of work,

r_s = average rate of return to investments in schooling,

r_p = average rate of return to post-school investment, and

T = the duration of post-school investment.

The model described in Equation 3 (which we refer to as the basic model) has been estimated widely with cross sectional data for male workers. When the model is applied to women, its explanatory power drops substantially. We would expect this basic model (which incorporates the assumption that N_i=0 in all periods) to be inappropriate for women with children in at least two ways. First, when N_i is greater than zero, investment (C_i) is overstated by $k_i N_i$. Moreover, if human capital depreciates when it is not in use, the basic model (which does not incorporate a depreciation term) fails to capture this phenomenon.

THE VARIABLE INTENSITY MODEL

If we relax the assumption that N_i equals zero in all periods, we can define the proportion of SWH devoted to all market activities (Li) as a measure of the "intensity" of market activity during the year so that

$$L_i = (Y_i+C_i)/E_i \tag{4}$$

Investment in any year (C_i) now depends on two proportions, K_i and L_i

$$C_i = k_i L_i E_i \tag{5}$$

Defining the rate of return (r_i) as before, potential earnings in the following year ($\hat{E}_{i+1}$), marked with a "$\wedge$" to indicate that intensity in the previous year was less than 1.0, becomes

$$\hat{E}_{i+1} = E_i + r_i k_i L_i E_i \tag{6}$$

A distinction is commonly made between human capital depreciation that occurs as a function of time (i.e., secular changes in the economy, changes in the state of knowledge, and changes in individuals due to aging) and depreciation that occurs because skills go unused. The first kind of depreciation is sometimes referred to as "obsolescence" or "strain," the second kind is called "atrophy."[8] Presumably, all skills are subject to the first kind of depreciation, and investment (Ci, as defined here) is implicitly net of such depreciation. The second form of depreciation, "atrophy," occurs when individuals are not at work and is therefore of particular interest when examining the experience of women with children. If we assume that skills depreciate

at a constant rate (d) when they are not used, the total human capital loss during any year i would be a function of initial human capital stocks, the depreciation rate and the portion of standard working hours allocated to nonmarket uses, changes in earnings potential due to depreciation would therefore be

$$\hat{E}_{i+1} = E_i - d(1-L_i) \tag{7}$$

Combining the effects of investment (Equation 6) and depreciation (Equation 7) yields

$$\hat{E}_{i+1} = E_i + r_i k_i L_i E_i - d(1-L_i)E_i \tag{8}$$

Equation 2 in the basic model corresponds to Equation 8 above, the difference representing the indirect cost (in terms of changes in earnings potential) of allocating the fraction (1-Li) of SWH to nonmarket activity. Subtracting Equation 8 from Equation 2 yields an estimate of the indirect costs (total change in earnings potential) due to time devoted to household production during year i.

$$E_{i+1} = E_i = r_i k_i E_i \tag{2}$$

$$\hat{E}_{i+1} = E_i + r_i k_i L_i E_1 - d(1-L_i)E_i \tag{8}$$

$$\text{Indirect Cost} = \hat{E}_{i+1} - E_{i+1} = \left[(1-L_i)(r_i k_i E_i)\right] + \left[d(1-L_i)E_i\right] \tag{9}$$

This loss in earnings potential is composed of two components (shown in square brackets), investment in OJT foregone and depreciation due to atrophy. When individuals allocate all SWH to market activity L_i is equal to 1.0 and the cost term is

equal to zero. The loss associated with <u>one</u> hour diverted from market to household activity is simply the change in cost (equation 9) due to a one hour change in hours worked,

$$\Delta \text{ Indirect Cost} = \left[\frac{r_i k_i E_i}{SWH}\right] + \left[\frac{dE_i}{SWH}\right] \qquad (10)$$

where the term in the first set of brackets is the value of investment foregone during one hour in year i and the second term is the cost of depreciation associated with that hour of nonmarket activity.[9]

The <u>full</u> cost of an hour at home is therefore composed of three components; wages foregone, investment foregone, and depreciation. These are shown in the three sets of brackets in equation 11.

$$\text{Full Cost of One Hour} = \left[\frac{(1-k_i)E_i}{SWH}\right] + \left[\frac{r_i k_i E_i}{SWH}\right] + \left[\frac{dE_i}{SWH}\right] \qquad (11)$$

Since work intensity (L_i) can be directly observed, estimation of opportunity cost requires developing estimates of the remaining parameters. The empirical section of this paper focuses on this estimation process.

Using Equations (1) and (8) and the same assumptions as were used to derive Equation (3), it can be shown (see Appendix) that the logarithm of wages in t (W_t) is approximated as a linear function of S, t, and two summed variables $\sum_{i=0}^{t-1} L_i$ and $\sum_{i=0}^{t-1} (2i+1)L_i$:

$$\ln W_t \approx (\ln E_{-s} - k_0 - \ln SWH) + r_s S + (r_p k_0 + d)\sum_{i=0}^{t-1} L_i$$

$$-\left[(r_p k_0)/2T\right]\sum_{i=0}^{t-1} (2i+1)L_i + \left[k_0/T - d\right]t \qquad (12)$$

It should be noted that the basic HCEF is a special case of this more general variable intensity HCEF. When labor force participation is constrained to be full-time in all periods (i.e., all L_i=1.0), the two models are identical. Since the basic HCEF assumes a value for L_i in all periods, it can be estimated with cross sectional data using a single wage observation, and data on years of schooling and years of experience (which is commonly inferred from age and final educational attainment). The variable intensity HCEF, on the other hand, requires panel data on work intensity.

THE DATA

A sample of 1,400 elementary school children was drawn from a single school district near New York City in 1975.[10] A mail questionnaire was sent to mothers in each family. In response to the initial mailing, 887 usable responses were received; of these, 535 provided information of the earnings, education and work experience of the women in the family. Comparable data were also provided for 437 husbands in the sample. The questionnaires contained, in addition to the information reported below,

detailed information on parental participation in a range of child-care activities during preschool and elementary school years. Family responses were merged with reading and math achievement data supplied by the school district.

THE VARIABLES

WAGE (W_t) An hourly wage rate for husbands and wives was constructed from earnings data. For individuals who separated from the labor force prior to 1975, the CPI was used to convert wages to a 1975 dollars.

SCHOOL (S) Respondents reported their own and husbands' educational attainment. The questionnaire truncated this variable at 17 years and all education in excess of 17 years is treated as exactly 17 years in the analysis.

EXPERIENCE (t) Potential experience was calculated by subtracting (Respondent's Age + SCHOOL + 6) from age in the year for which wages were reported.

EXPERIENCE SQUARED (t^2)

INTENSITY (L_i) Intensity is defined as the proportion of standard working hours (SWH) devoted to market activities. In this analysis the standard was set at 1,875 hours per year.[11] For men in the sample, L_i was assumed to be 1.0 in all periods. For women, retrospective measures of intensity were reported for seven years or about half the average potential experience interval. For the remaining years, a value of L_i was imputed based upon information on the presence of preschool children at home and actual labor supply during the seven years for which data were available. A variety of techniques were used in treating missing data, and findings remained stable across methods.[12]

SUMLAM ($\sum_{i=0}^{t-1} L_i$) The sum of intensity across all years of potential experience, computed for the wives only. If L_i had equaled 1.0 in all periods (the assumption used for the husbands), SUMLAM would equal EXPERIENCE.

SUMSAT[$\sum_{i=0}^{t-1} (2i+1)L_i$] Like SUMLAM, this variable was computed only for the wives. If L_i had equaled 1.0 in all periods, SUMSAT would equal EXPERIENCE SQUARED.

HOURS PER WEEK Hours worked in the most recent week of employment.

Table 1 shows the means and standard deviations of all variables. While men and women in this sample had similar levels of education, their hourly wages differed by a ratio of almost two to one. Men had, on average, approximately seven more years of potential experience than the women and worked about sixty percent more hours in the current (or most recent) work week.[13]

(Insert Table 1 here)

EMPIRICAL RESULTS

Ordinary least square estimates of both earnings models are provide in Table 2. While the basic model fits the men's data well, it does not provide meaningful estimates for the women. The estimated coefficients on both experience variables are statistically nonsignificant. The variable intensity HCEF, on the other hand, provides significant coefficients on all variables which are consistent with the predictions of the model.[14]

(Insert Table 2 about here)

While both models provide direct estimates of the rate of return to investments in schooling, they are underidentified in terms of the remaining parameters. A common approach to resolving the identification problem is use of the assumption that the rates of return to schooling and post-school investment are equal ($r_p = r_s$).[15] Table 3 provides estimates of these human capital parameters using the basic model for the men and the variable intensity model for the women. In addition, a range of estimates of each parameter is provided for the women which corresponds to the four treatments of missing data described in Footnote 12.

(Insert Table 3 about here)

The estimated rate of return to investments in human capital (r_s and r_p) is high for both men and women in this sample; although the men appear to be at some advantage (about three percent per year). The duration of post-school investment is similar for both groups, and seems quite reasonable for a group with high levels of education. The proportionate investment profile is substantially higher for the women than for the men.[16] These estimates suggest that men invest about one third of potential earnings in OJT during the first period following job entry compared to women who invest almost 40 percent. Of course, in the variable intensity model, where actual investment (C_i) depends both on the portion of SWH spent in the market (L_i) and the allocation of market time between investment and income (k_i), higher hourly profiles do not necessarily mean higher proportionate annual investment. In fact, for this sample, where women worked about sixty percent as many hours as men in the most recent period, annual proportionate investment was lower for women than

for men. Finally, the annual rate at which human capital is estimated to depreciate due to nonuse is about 4.24 percent.

The human capital estimates provided in Table 3 are reasonable and they are consistent with estimates obtained in other analyses.[17] These findings suggest that these two models are appropriate to the work experience of men and women respectively.

The estimates provided in Table 3 can be used to examine the costs of time allocated to households activity and the commulative impact of such allocation over a number of periods. The first two columns in Table 2 provide a direct indication of the shape of the age-earnings profiles for men and women in this sample. Assuming comparable "human capital stocks" at the time they began school, male earnings potential is estimated to grow at about 16 percent per year (coefficient on "SCHOOL") while, for women, the growth rate is between 12 and 13 percent. This difference in the rate of return, combined with the fact that men had, on average, 8 months more schooling, suggests that at the completion of school men would have substantially higher potential earnings

While these school-related differences are substantial, differences in the post-school profiles are of particular interest here because these reflect the impact of time allocated to child-care in the home. For the men, the post-school profile suggested by the Basic HCEF is one regularly observed in age-earnings data. Wages rise steeply following the completion of school and the rate of growth decreases with time. For women, on the other hand, no wage growth is indicated. The hypothesis that wages and experience are unrelated cannot be rejected and visual inspection of the wage experience profile confirms that it is flat. For this group then, there is no statistically significant growth in earnings over the average twelve year interval reported. Either learning is not occurring at work or skills acquisition is offset by depreciation.

According to the models specified above, differences in the shapes of the two earnings profiles are determined by differences in the way men and women allocate time between market and home activity. For the men in this sample, the implicit assumption of the Basic HCEF is that intensity (L_i) is equal to 1.0 in all periods. For the women, reported retrospective measures of time allocation are used. Figure 1 shows a twenty year profile of work intensity as reported by women in the sample. In all periods average intensity is less than half of that assumed for the men. The profile is well defined and clearly reflects the impact of children upon the labor supply of their mothers. In this sample, women had, on average, 2.76 children spaced 2.94 years apart. The mean interval between school completion and the birth of the first child was 5.11 years.

(Insert Figure 1 about here)

The impact of this pattern of time allocation upon human capital stocks and wages can be inferred from the Variable Intensity HCEF. Table 4 traces the wage pattern of women over the average 12.5 post school interval; group mean values on education, experience and annual work intensity, combined with the estimated human capital parameters (shown in Table 3) are substituted into equation 8 recursively to construct the table. The second column of Table 4 presents estimates of the hourly wage rates of women in the sample. The constructed profile like to observed profile is essentially flat.

According to our model, in any specific period i the observed hourly wage (Wi) depends upon two factors--the individuals potential hourly earnings (E_i) and the share of potential earnings invested in on-the-job training (k_i). The hourly wage itself is equal to $E_i(1-k_i)$--the share of potential earnings taken as wages. Our data suggest

that, on average, women completed school with an earnings potential of $11.51 per hour[18] (Column 3) and invested forty percent during each hour actually worked (k_i in column 9) in OJT.

(Insert Table 4 about here)

Earnings potential (E_i) depends, in turn, upon two aspects of time allocation in the previous period (i-1). Total investment is determined by both the proportion of time invested when at work (k_i) and the allocation of standard working hours (SWH) between market and home activity (L_i). Columns 6 through 8 show the average proportional allocation of SWH among household activity (6), money income (7) and investment through OJT (8). By construction, columns 6 through 8 sum to 1.0. The proportion shown in column 6 is therefore always equal to $1.0-L_i$ which corresponds to the area above the curve in Figure 1. The proportionate investment profile (k_i) is shown in column 9, is the ratio of investment to potential earnings when at work. That is, column 8 divided by the sum of columns 7 and 8.

The impact of this allocation of SWH between home and market activity (L_i) and of market time between wages and investment (k_i) can be seen in columns 10 through 12. Column 10 shows the effects (in dollars per hour) of investment in each period upon hourly earnings potential in the next period. Equation 6 defined the impact of investment in period i upon earnings potential in the next period (i+1). From equation 6, it is clear that this change in full time earnings potential is

$$E_{i+1}-E_i = r_i k_i L_i E_i \qquad (13)$$

The estimated average rate of return (r) for this sample was 12.58 percent. Potential Earnings (E_i) are equal to potential hourly earnings (column 3) multiplied by SWH (1,875). Proportionate investment in each period (k_i) is shown in column 9. Work Intensity (L_i) is, by definition, 1.0 minus the share of SWH allocated to household activity (column 6). During the first period (i=0), for example, investments in on-the-job training would increase earnings potential in the next period (i+1) by $510.40 dollars.

$$E_{i+1} - E_i = r_i k_i L_i E_i$$

$$= (.1258)\,(.40)\,(1.0-.53)\,(\$11.51 \times 1{,}875) = \$510.40$$

That is, an increase of $0.27 in earnings potential in each of the 1,875 SWH in the following year (column 10).

Hourly losses due to depreciation (shown in column 11) are similarly derived from equation 7.

$$E_{i+1} - E_i = -d(1-L_i)E_i \qquad (14)$$

During that first year, the average respondent allocates 53 percent (column 6) of SWH to household activities. Since human capital stocks are estimated to depreciate at 4.24 percent, earnings potential is estimated to decrease by $0.25 per hour due to nonuse. The net effect of investment and depreciation is shown in column 12. That is, if upon school completion, potential earnings were $11.51, potential earnings would grow by 2 cents per hour during the first year due to the way time had been allocated.

The hourly wage and potential earnings profiles shown in columns 2 and 3 reflect successive substitution of the estimates of investment and depreciation parameters

into equation 8. By way of comparison, columns 4 and 5 show hypothetical wage and potential earnings profiles use the same parameters and the assumption that all SWH were allocated to market activity in each period. That is, column 4 provides an estimate of what the model suggests wages would have been in each period had time not been allocated to the home at the cost of market experience. We can see that while the initial hourly wage is the same in both cases, after 12 years, the observed wage is about half of what it would otherwise have been. That is, the cummulative effect of time away from the market was to reduce earnings power by almost half.

While the presence of children at home is an important determinant of labor supply, it is not reasonable to attribute all time out of the market to "investments" in children. In examining resource allocation to children in the home, it is informative to look at the full cost of allocating one hour from market to home activity, and the pattern of this shadow wage over the post school period.

Equation 11 defines the full cost of an hour diverted from market to household activity. These three components (enclosed in sets of square brackets) are wages foregone (column 13), investment foregone (column 14) and depreciation (column 15). The total cost of an hour (the sum of the three components) is shown in column 16. We can see that in the first period, direct wages foregone represent less than half of the total cost of an hour allocated to child care (column 17). The average cost of one hour diverted from market to home activity is shown in Figure 2. For these women, the share of total costs captured by the observed wage rate increases from less than half to almost two thirds. The importance of OJT foregone drops substantially because of the shape of the proportionate investment profile (k_i in column 9). The decrease in the depreciation associated with an hour of home time reflects the decrease in earnings potential starting in year three (column 3). The pattern in observed earnings (column

2) differs from the pattern in earnings potential (column 3) because of the proportionate investment profile.

(Insert Figure 2 about here)

IMPLICATIONS FOR SCHOOL FINANCE

The findings reported here must be considered preliminary for several reasons. First, the sample used is atypical; education and income are higher then in the general population and inputed shadow wages are consequently higher. Moreover, the estimates we provide are based on respondents only, no correction for self-selection bias has been made. In addition to these sampling issues, there are a number of methodological questions which remain open. We have specified the proportionate investment profile as linear (the assumption commonly used for men); for women with children, a step function might be more appropriate.[19] The regression estimates presented in Table 3 include the log of current hours as a regressor. While this specification does not significantly change estimates of the parameters of interests, inclussion of the variable rests, in part, on statistical rather than theoretical grounds as described in footnote 14. Finally, work intensity is treated as exogenous. It might be more appropriate to specify a model in which labor supply, and perhaps numbers and ages of children, are endogenous.

Despite these limitations, the estimates of human capital parameters (investment profile, rates of return and depreciation) seem quite reasonable and the analysis has a number of interesting implications. First, there is strong evidence that estimates of the cost of children which ignore the opportunity cost of maternal time (or value it at only the imputed rate of wages foregone) substantially underestimate

the full cost of time with children. The methodology presented here provides an improved tool for estimating these costs. In terms of school finance, the research has several implications. First, differences between households in the total value of time allocated to children may prove useful in predicting family behavior under a tuition tax credit arrangement. That is, parental willingness and ability to incur costs at home may be a good indication of the family's propensity to invest in (tuition-subsidized) private schools.

In addition, improved estimates of the full cost of resources allocated to educational activities may help to explain why school effects are generally dwarfed by family effects in production function research. We may find that the direct costs of schooling represent a relatively small share of total resources allocated to children's education. For example, in this district, expenditure per student in ADA in 1975 was $2,590 (about 150 percent of the national average).[20] Using our estimated hourly cost for parental time (column 16, Table 4), it is clear that relatively small differences in home inputs would exceed the total dollar value of resources allocated at school. At $14.00 per hour, a change of only 30 minutes per day in parental time is equivalent to the full value of resources at school. Given that students spend only about 15 percent of their waking hours in school during their first 18 years, differences in the value of home time are likely to dwarf the total value of resources allocated to formal schooling.

Finally, estimates of the full cost of home time have potentially important implications for public policy in areas such as the provision of preschool. Clearly, the observed, or inputed, hourly wages forgone to provide child-care services substantially underestimate the full cost to families and society of these activities.

FOOTNOTES

1. Allan J. Thomas, "Issues in Educational Efficiency," in School Finance Policies and Practices, ed. James W. Guthrie (New York: Ballinger, 1980), p. 147.

2. James Coleman, Thomas Hoffer and Sally Kilgore, Private and Public Schools (Washington, D.C.: National enter for Educational Statistics, 1982).

3. Barbara K. Iverson and Herbert J. Walberg, "Home Environment and School Learning: A Quanititative Synthesis," Journal of Experimental Education 50, no. 3 (1982): 144-151, provide an overview and synthesis of research in this area.

4. While there is strong evidence indicating that more educated parents allocate more time per child, at home. See, for example.

4. See, for example, Arleen Liebowitz, "Home Investments in Children," Journal of Political Economy (March/April 1974): S111-131 and C. Russell Hill and Frank P. Stafford, "Allocation of Time to Preschool Children and Educational Opportunity," Journal of Human Resources (Summer 1974): 323-341.

5. Sherwin Rosen, "Measuring the Obsolescence of Knowledge," in Education and Human Behavior, ed. E. Thomas Juster (New York: McGraw-Hill, 1975), pp. 199-232. Jacob Mincer and Solomon W. Polachek, "Family Investments in Human Capital: Earnings of Women," Journal of Political Economy (March/April 1974): S76-110.

6. Two earnings models are utilized in the analyses presented here. The "basic" model is presented in Jacob Mincer, Schooling, Experience and Earnings (New York: Columbia University Press, 1974). The "variable intensity" model is developed in Victor Levine and Peter R. Moock, "Labor Force Experience and Earnings: Women With Children," Economics of Education Review 3, No. 3 (in press). The concept of variable intensity was suggested by Eric A. Hanushek and J. M. Quigley, "Implicit Investment Profiles and Intertemporal Adjustments of Relative Wages," American Economic Review 68, No. 1 (March 1978): 67-90.

7. Mincer, Schooling, Experience and Earnings.

8. See Sherwin Rosen, "Measuring the Obsolescence of Knowledge," for a discussion of "obsolescence." Mincer and Polachek introduce and define the concepts of "atrophy" and "strain."

9. Equation 10 is derived by substituting (Actual Hours Worked/SWH) for intensity in equation 9 ($L_i = H_i/SWH$). Delta Cost is found by evaluating equation 10 using H_i/SWH and H_{i+1}/SWH, and taking the difference.

10. A copy of the survey instrument and details of the design can be found in Ronald G. Crawford, "Family Characteristics and Choice of Alternative Educational Programs" (Doctoral dissertation, Columbia University Teachers College, 1977).

11. This value (1875 hours per year) is representative of the Northeastern urban location where the study was conducted. The variable intensity model, as used in this paper, assumes that hours above 1875 do not enhance human capital. This is, intensity above 1.0 does not cause additional investment.

12. Since the average potential experience of women in this sample was 12.5 years and direct observations of hours worked were available for only seven years, imputed values were generated for missing periods. The following assumptions were employed to arrive at the results reported here: (1) a women worked 50 percent of the time between the completion of school and the birth of her first child; (2) in any year that she had a child at home aged zero to six years, the women worked the same percentage of time as she did when the sampled child was this age; (3) when more than one pre-school child was present, the percentage of time worked was determined by the youngest child; and (4) after the youngest child reached age six, the women worked the same percentage of time as reported for her most recent job. To determine the sensitivity of the results to the assumptions used in imputing values of lambda for missing years, we tried two alternative (and somewhat more complex) sets of assumptions and also derived instrumental estimates of intensity based on the respondent's education and religion, her husband's education, and the age of the youngest child at home. In general, results were quite stable across equations. See Victor Levine, "Work Intensity and Human Capital Accumulation: Women with Children" (Ph.D. dissertation, Columbia University, 1980).

13. This difference in potential experience reflects the combined impact of age differences and the fact that women, more often than men, left the labor force prior to the survey year.

14. The estimates shown in Table 2 include in HOURS PER WEEK as a regressor in all three equations. While this variable is clearly required when annual earnings are the dependent variable, its inclusion in a wage model does not flow directly from the model. We found that the inclusion of this variable reducd the standard error on the other coefficients without changing their estimated mean values significantly. See Levine "Work Intensity" for an interpretation of this coefficient and an explanation of its inclusion in the model. .

15. While optimizing behavior would suggest seeking equivalent returns on marginal dollars invested in each area, the HCEF provides estimates of average rates of return. Since investments in OJT occur later in life, and life is of definite duration, equal marginal rates of return would suggest higher average rates of return to post-school investment.

16. The proportionate investment profile specified in the variable intensity HCEF refers to the proportion of <u>hourly</u> potential earnings. When intensity is less than full, annual proportionate investment is equal to the product $L_i k_i$. On an annual basis, the proportionate investment profile is lower for the women than for the men.

17. For a comparable sample of women in the National Longitudinal Survey of Mature Women, Mincer and Polachek "Family Investments" estimated an atroply rate of 4.3 percent.

18. Investment foregone in a single hour (column 14) and the total impact of investment (as determined by the allocation of time column 10), are related as follows. In the first year, for example, invest $4.58 during each hour of market activity ($C_i=E_ik_i$). Total annual investment is therefore $4.58 time 881.25 hours worked, or $4,036. Hours worked is, of course, SWH $(1-L_i)$=(1,875 x .47). The estimated return on the annual investment is r_pC_i (.1258 x $4,036) = 507.73, or $0.27 during each of 1,875 potential SWH.

19. The profile relates to investment as a proportion of potential earnings during hours worked. Since the proportionate profile of full potential earnings is the product of k_i times L_i is quadratic (convex from above), the profile of proportionate investment of potential earnings is not monotonic. In fact, it resembles that suggested by Mincer and Polachek. See Levine, 1980.

20. Data on cost per student in ADA in this district for 1975 were provided by the Division of Educational Finance, New York State Department of Education.

TABLE 1

MEANS AND STANDARD DEVIATIONS

Variable	Men		Women	
	Mean	Std. Dev.	Mean	Std. Dev.
WAGE (dollars/hour)	14.78	7.67	7.47	6.64
SCHOOL (years)	15.71	2.01	14.96	2.04
EXPERIENCE (years)	19.51	6.22	12.43	7.35
EXPERINECE SQUARED	419.04	272.82	208.28	212.89
SUMLAM	----	----	4.21	3.30
SUMSAT	----	----	70.16	99.57
HOURS PER WEEK				
in (WAGE)	2.57	0.52	1.81	0.57
in (HOURS PER WEEK)	3.80	0.22	3.21	0.62
N	437		535	

TABLE 2

OLS ESTIMATES OF HUMAN CAPITAL EARNINGS MODELS

Independent Variables	Basic HCEF		Variable Intensity HCEF
	Men	Women	Women
SCHOOL	.1595 (4.56)	.1261 (11.88)	.1258 (12.47)
EXPERIENCE	.0716 (5.05)	.00384 0.38)	-.0217 (4.88)
EXPERIENCE SQUARED	-.00146 (4.51)	-.00029 (-0.84)	------
SUMLAM	------	------	.09241 (5.20)
SUMSAT	------	------	-.0012587 (-2.00)
ln (HOURS PER WEEK)	-.3994 (-4.56)	-.2044 (-5.76)	-.30676 (-8.10)
constant	.7897	.5966	.8841
Adj. R^2	.396	.260	.328
N	437	535	535

Note: The dependent variable is lnWAGE; t-statistics are in parentheses.

TABLE 3

ESTIMATES OF HUMAN CAPITAL PARAMETERS

	Men	Women	
Rate of Return to Investment in School and OJT	.1595	.1258	(.126-.140)
Duration of Post-School Investment Period	18.3	19.2	(13.3-20.4)
Proportionate Investment in 1st Work Period	.33	.40	(.37-.48)
Rate of Depreciation Due to Atrophy	---	.0424	(.042-.052)

Note: These estimates are derived from columns 1 and 3 of Table 2 for men and women respectively. The interval shown in parentheses indicates minimum and maximum values based upon alternative treatment of missing values of the intensity measure.

TABLE 4

THE IMPACT OF WORK INTENSITY UPON HUMAN CAPITAL ACQUISITION AND LOSES

Year	Hourly Earnings Profile: Actual Wage	Actual Potnl	Hypothetical Wage	Hypothetical Potnl	Allocation of Standard Working Hours: Hm	Wage	Invt	k_j	Change in Hourly Earnings Potential: Rtrn	Depr	Net	Full Cost of one Hour Foregone: Wage	Invt	Depr	Total	Observed % of Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
0	6.93	11.51	6.93	11.51	.53	.28	.19	.40	.27	.25	.02	6.93	4.58	3.88	15.39	45.05
1	7.18	11.53	7.53	12.09	.51	.30	.18	.38	.27	.25	.02	7.18	4.34	3.88	15.41	46.60
2	7.43	11.54	8.15	12.66	.59	.26	.15	.36	.21	.29	.08	7.43	4.11	3.89	15.43	48.15
3	7.62	11.46	8.79	13.23	.63	.25	.13	.34	.18	.30	.12	7.62	3.85	3.86	15.33	49.69
4	7.77	11.34	9.44	13.78	.67	.23	.10	.31	.15	.32	.17	7.77	3.57	3.82	15.16	51.24
5	7.88	11.16	10.12	14.33	.71	.21	.09	.29	.12	.33	.21	7.88	3.28	3.76	14.93	52.79
6.	7.96	10.95	10.80	14.86	.74	.19	.07	.27	.10	.35	.25	7.96	2.99	3.69	14.64	54.34
7.	8.00	10.70	11.49	15.37	.76	.18	.06	.25	.08	.34	.26	8.00	2.70	3.61	14.31	55.89
8.	8.02	10.44	12.18	15.86	.78	.17	.05	.23	.07	.35	.28	8.02	2.42	3.52	13.96	57.44
9.	8.01	10.16	12.87	16.32	.79	.16	.04	.21	.06	.34	.29	8.01	2.15	3.42	13.58	58.99
10.	7.99	9.87	13.56	16.76	.78	.18	.04	.19	.05	.33	.27	7.99	1.88	3.33	13.20	60.54
11.	7.97	9.60	14.24	17.16	.76	.20	.04	.17	.05	.31	.26	7.97	1.63	3.24	12.83	62.09
12.	7.95	9.34	14.91	17.53	.75	.21	.04	.15	.04	.30	.25	7.95	1.39	3.15	12.49	63.64
13.	7.92	9.09	15.56	17.85	.72	.25	.04	.13	.04	.28	.24	7.92	1.17	3.06	12.15	65.19

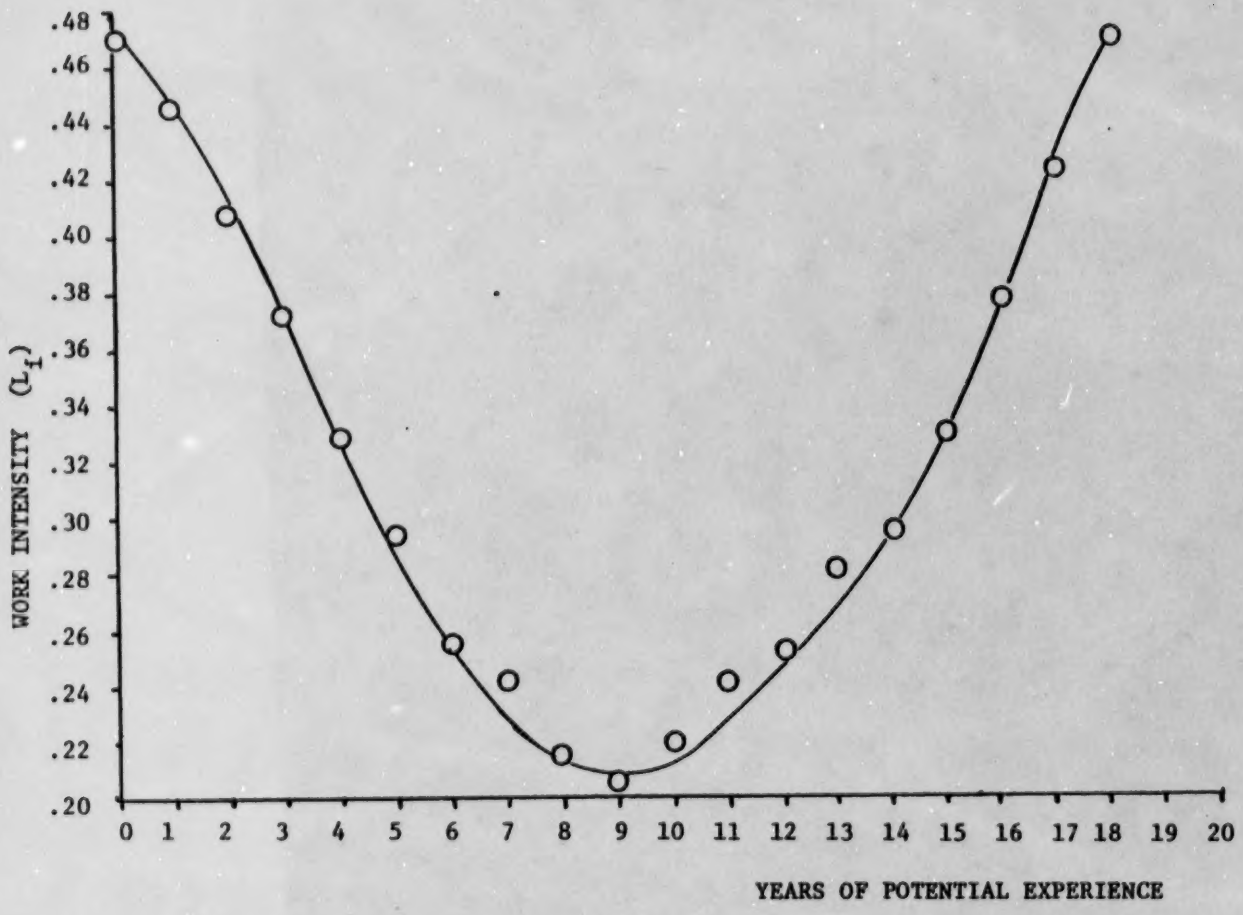

FIGURE 1

WORK INTENSITY - POTENTIAL EXPERIENCE PROFILE

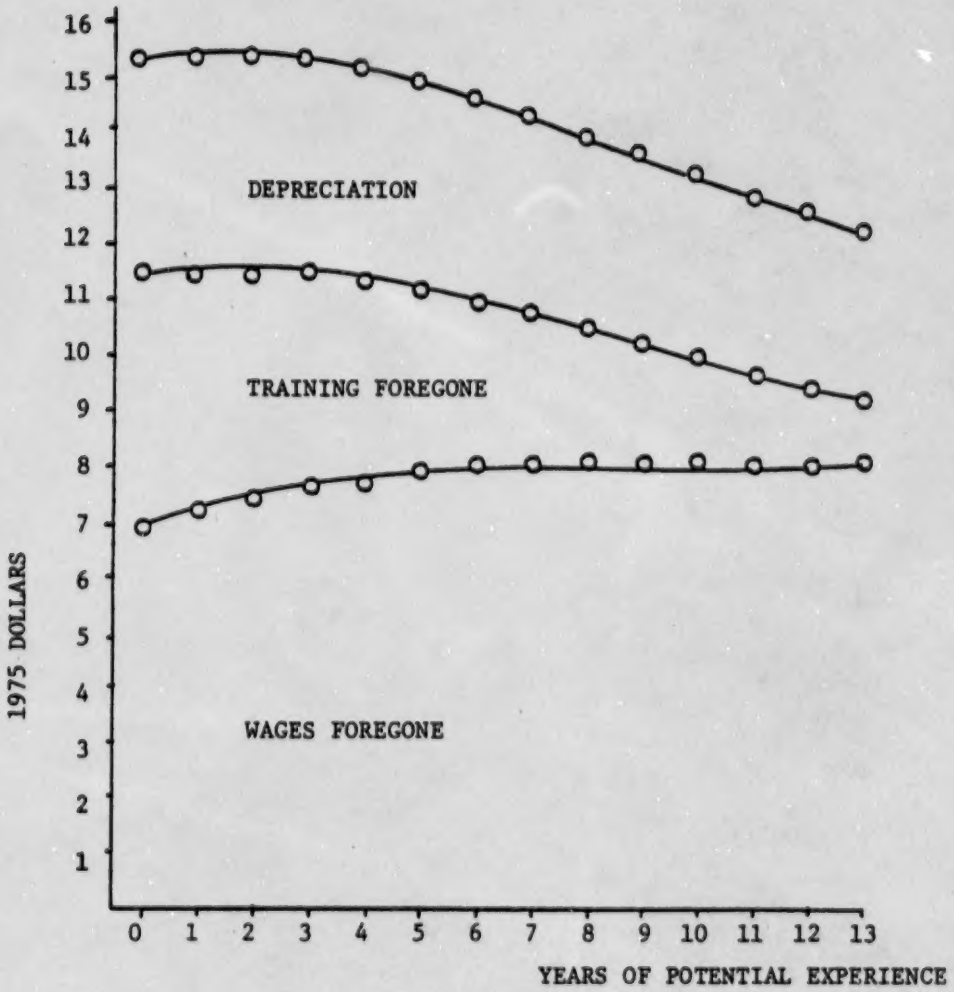

FIGURE 2

FULL COST OF ONE HOUR DIVERTED

FROM MARKET TO HOME ACTIVITY